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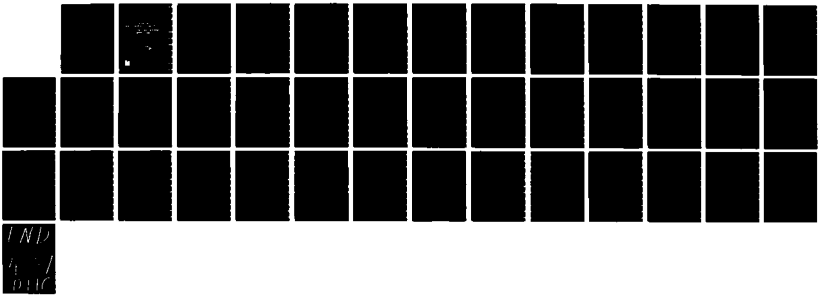

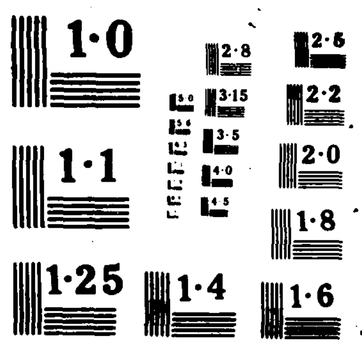
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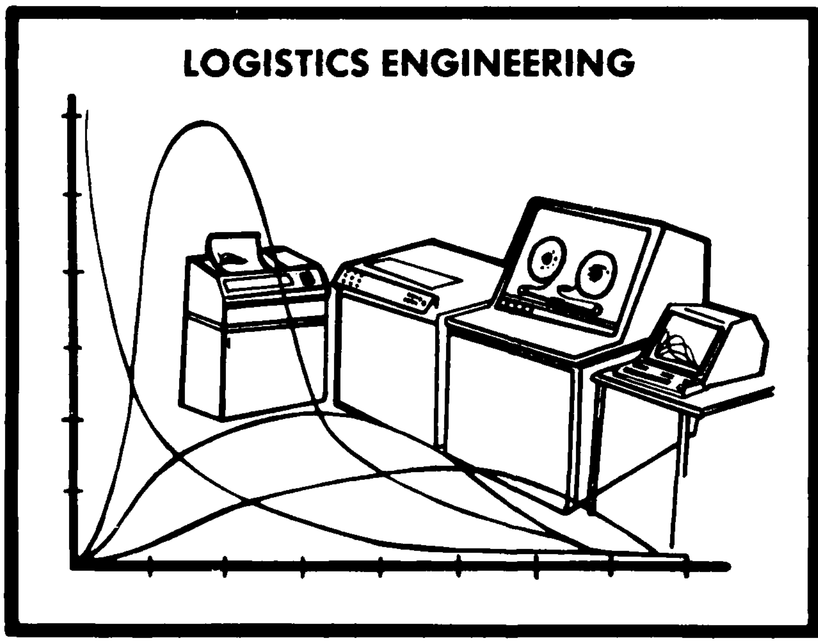
MRSA LSAT 86-02

LOGISTICS SUPPORT ANALYSIS TECHNIQUES INFORMATION

AD-A178 092

TECHNICAL REVIEW AND ANALYSIS OF

CENTER FOR NIGHT VISION & ELECTRO-OPTICS LIFE CYCLE COST ANALYSIS MODEL (CNVEO LCCAM)



SEPTEMBER 1986

PREPARED BY

US ARMY MATERIEL COMMAND
MATERIEL READINESS SUPPORT ACTIVITY
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18. ABSTRACT

The Technical Review and Analysis(TRA) report of the Center for Night Vision and Electro-Optics Life Cycle Cost Anlaysis Model (CNVEO LCCAM) was conducted to access the potential use of CNVEO LCCAM in satisfying the Logistic Support Analysis tasks set forth in MIL-STD-1388-1A, and quantify the degree by which the methodology can satisfy these tasks. Topics discussed in this TRA include validity of calculations/equations, documentation, input requirements, output products, and strengths and limitations of the methodology. This report may serve as an executive summary to CNVEO LCCAM for someone who is considering using the methodology and would like an overview to determine its potential use.

ACKNOWLEDGEMENT

The U.S. Army Materiel Command (USAMC) Materiel Readiness Support Activity (MRSA) is responsible for the planning and execution of the Center for Night Vision and Electro-Optics Life Cycle Cost Analysis Model (CNVEO LCCAM) Technical Review and Analysis (TRA) and for the preparation of the TRA report.

The MRSA analysis team for this TRA consisted of the following personnel: Mr. John Peer, MRSA LSAT coordinator; Mr. Leslie Adkins, Chief, Engineering Analysis Section; Ms. Carolyn Bell-Roundtree, team chief; Mr. Jim Crabtree, advisory assistant; and, Ms. Betty Clarke, clerk-typist.

The MRSA team would like to especially thank the following personnel for their efforts/assistance: Mr. John Swenson, Mr. Joe Latchaw, and Mr. Everett Dunn from the Center for Night Vision and Electro-Optics, Fort Belvoir, Virginia.

DISCLAIMER

This TRA was conducted by USAMC MRSA to provide an independent evaluation of CNVEO Life Cycle Cost Analysis Model. The contents of this report represent the views, conclusions, and recommendations of the Commander, MRSA, and do not necessarily reflect the official views of the Department of the Army or HQ AMC. MRSA is prepared to discuss all issues and findings of this TRA at the discretion of HQ AMC or the requesting agency/activity.

TABLE OF CONTENTS

SECTION I. EXECUTIVE SUMMARY.

A. INTRODUCTION. This Technical Review and Analysis (TRA) was conducted to evaluate the potential use of the Center for Night Vision and Electro-Optics Life Cycle Cost Analysis Model (CNVEO LCCAM) in satisfying the Logistic Support Analysis (LSA) tasks set forth in MIl-STD-1388-1A, Logistic Support Analysis, 11 Apr 83. This report is the result of an in-depth review of the LCCAM documentation in accordance with the methodology identified in Section II, paragraph B. This report centers on the ability of the model to fulfill the features stated in the documentation and the model's applicability to MIL-STD-1388-1A tasks. Proposals for modification or inquiries with respect to the application of LCCAM should be addressed to Commander, USAMC Materiel Readiness Support Activity, ATTN: AMXMD-EL, Lexington, KY 40511-5101. Telephone inquiries should be addressed to Ms. Carolyn Bell-Roundtree, AUTOVON 745-3986, or commercial (606) 293-3986.

B. COORDINATION. The final report for LCCAM TRA was coordinated with CNVEO, and the members of the LSA Technical Working group (LSA-TWG).

C. BACKGROUND. LCCAM was developed at CNVEO to fulfill the need for an in-house capability to conduct life cycle cost analysis on programs with high costs. The need for an in-house capability to conduct life cycle cost resulted from an increase in operation and support costs, the rising complexity of materiel systems, and the need for effective management.

LCCAM was first used at CNVEO on the Phase I Engineering Development Source Selection Evaluation for the Tube-Launched, Optically Tracked, Wire Guided (TOW) Night Vision System.

In 1975, LCCAM was used in the Phase II Source Selection Evaluation for the Infrared Night Vision Sight (AN/TAS-4) used with the TOW system.

The model was enhanced in 1981 by adding the DA Pam submodel. The DA Pam submodel estimates life cycle costs on a year-by-year basis for the Research and Development (R&D) phase, the Investment phase, and the Operation and Support phase of the life cycle. The DA Pam submodel conforms to DA Pam 11-1 through 11-4.

LCCAM was further enhanced in 1985 by adding the Baseline Cost Estimate (BCE) submodel. The BCE submodel estimates life cycle costs on a year-by-year basis for the R&D, Military Construction, Production, Fielding, and Sustainment phases of the life cycle. The BCE submodel conforms to the DCA-P-92(R), Instructions for Reformatting the BCE/Independent Cost Estimate (ICE), dated 15 May 84. It is primarily directed toward the program management community.

D. SUMMARY OF FINDINGS.

1. LCCAM is applicable to the following MIL-STD-1388-1A tasks: 203, Comparative Analysis; 205, Supportability and Supportability Related Design Factors; 302, Support System Alternatives; and, 303, Evaluation of Alternatives and Trade-off Analysis.

NOTE: Although LCCAM does not completely satisfy all the tasks listed above, it can be useful in performing these tasks. A more detailed description of task applicability is provided in section III.

2. LCCAM interfaces with LSA records by providing data to or obtaining data from the following LSAR Data Records:

A - Operation and Maintenance Requirements.
B - Item Realiability and Maintainability Characteristics.
E - Support Equipment or Training Material Description and Justification.
H - Support Items Identification.
J - Transportability Engineering Characteristics.

3. LCCAM is written in Fortran IV. The model is on the IBML4341 computer system at CNVEO. MRSA used the IBM 381k, located at the University of Kentucky, to execute LCCAM.

4. The equations used in LCCAM were found to be in accordance with DA Pam 11-2 through 11-4, and the definitions contained in Technical Report DCA-P-92(R), Instructions for Reformatting the BCE/ICE.

5. Accuracy and credibility of the results depend heavily on the quality of the data. LCCAM requires a significant amount of data to achieve credible results; however, this is true of any cost model that does not contain or access an extensive data base.

6. LCCAM is designed primarily for electronic and electro-optical systems.

7. LCCAM requires 2500k of storage (virtual machine size) to execute in the interactive environment.

E. AVAILABILITY. LCCAM is available at the U.S. Army Communication and Electronic Command, Center for Night Vision and Electro-Optics , Fort Belvoir, VA 22060. Documentation for the model includes the NVEO Labororatory Life Cycle Cost Analysis Model User's Manual, dated 5 Aug 83; NVEOL Life Cycle Cost Analysis Model Summary of Revised BCE Format; NVEOC Life Cycle Cost Analysis Interactive Data Entry System User's Manual (CAIDES); and, Interactive Data Entry System User Manual - Notes.

NOTE: NVEOL, Night Vision and Electro-optics Labororatory, and NVEOC, Night Vision and Electro-Optics Center are synonymous to CNVEO, Center for Night Vision and Electro-Optics.

F. CONCLUSIONS.

MRSA's conclusions are as follows:

1. LCCAM can be used as a tool in performing the LSA tasks listed previously in the summary of findings, paragraph 1.

2. The mathematical model for LCCAM is in accordance with Army regulations. LCCAM is an automated technique.

3. LCCAM is designed to estimate Life Cycle Cost for electronic and electro-optical systems. The model may also be used to estimate cost for some mechanical systems, provided the system is composed of removable and replaceable components and the failure rate of the mechanical system approaches that of the exponential distribution.

4. LCCAM depends heavily on the quantity and quality of data available for conducting the analysis. The results of LCCAM will be as reliable as the data utilized for input.

5. LCCAM can be used to estimate costs in the Demonstration and Validation and the Full Scale Development Phases of the life cycle. LCCAM can be used in the Concept Phase to estimate costs only if historical data or a comparative system exists.

6. LCCAM is a good technique for conducting life cycle cost estimates of electronic and electro-optical systems.

SECTION II. TECHNICAL REVIEW AND ANALYSIS (TRA).

A. PURPOSE. A TRA is conducted to assess the ability of an LSA technique to satisfy the tasks set forth in MIL-STD-1388-1A. The objectives of the analysis are: (1) to determine resources required to utilize the model; and, (2) to determine areas of application. The TRA investigates all aspects of an LSA technique, including user training availability, computer resources requirements, documentation availability, conformity with regulatory guidance, and validity of input requirements and output reports.

B. EVALUATION METHODOLOGY. The analysis was accomplished by first analyzing the requirements of each of the tasks described in MIL-STD-1388-1A to determine if the technique could be applied to any of the LSA tasks. Each of the subtasks which make up an applicable task were then analyzed to determine to what extent the technique could satisfy the requirements of the task. Attention was also given to the output used and to which phase(s) of the life cycle it could be applied. Calculations and defined equations were compared with regulatory requirements which govern Life Cycle Cost. All available documentation were gathered and surveyed for accuracy, completeness, and ease of application.

C. COORDINATION. The TRA report of LCCAM was coordinated with CNVEO and members of the LSA-Technical Working Group (TWG). The findings, conclusions, and recommendations will be presented during the LSA-TWG meeting, second quarter fiscal year 1987.

D. TECHNIQUE DESCRIPTION.

The CNVEO LCCAM is designed to provide an estimate of life cycle cost for electronic and electro-optical systems. The model generates total program life cycle cost on a year-by-year basis for advanced development and engineering development costs, investment costs, and operation and support costs for a materiel system.

The CNVEO LCCAM is capable of outputting the life cycle cost summary in constant, current, or present value dollars. The model is designed to manage detailed modular structure and component or modular commonality. Modules are removable and replaceable components of electro-optical/electronic systems (EO/E). The EO/E systems may be attached to another system such as a tank, helicopter, or weapon. The total system is composed of the EO/E system and the system to which it is attached; however, EO/E systems may be both system and subassembly as is the case of night vision goggles. In order to distinguish between the total system and EO/E systems, EO/E systems will be referred to as EO/E equipments.

Since EO/E equipments are composed of one or more modules, the total system failure can be fault isolated to a defective module. Thus, failure of a module causes failure of the EO/E equipment which causes total system failure. LCCAM methodology uses a three level maintenance concept to correct system failure.

The subsystem is removed at Direct Support (DS). General Support (GS) isolates and removes the defective module. The depot repairs and returns the module. No maintenance is performed at the organizational level. The three level maintenance policy can be modified to fit combinations of the above concept. This combination may be accomplished through the following variables:

TURN(1) - Turnaround time between user and DS
TURN(2) - Turnaround time between DS and GS
TURN(3) - Turnaround time between GS and Depot
FMTTR1 - Meantime to repair at DS
FMTTR2 - Meantime to repair at GS

For example, if TURN(1) and FMTTR1 are both set to zero, then maintenance will be performed at GS and Depot. If all variables are set to zero except turn(3), then the maintenance will be performed at Depot. The turnaround time for maintenance performed at Depot only will be between the user and Depot.

The turnaround time for repair determines the number of EO/E equipment and module maintenance floats to have on hand. The turnaround time occurs from the time a float item has been taken out of the supply of floats and used to replace a failed item, to the time when that failed item is repaired and can be used as a float.

The CNVEO LCCAM consists of three submodels. Each submodel provides an estimate of total life cycle cost. The NVL submodel was the original model created in 1970 at NVEOC to fulfill the need for an in-house life cycle cost analysis method.

The DA Pam submodel conforms to DA Pam 11-2, 11-3, and 11-4. The submodel generates total life cycle costs estimates for the R&D, investment, and the operation and support phases of the life cycle.

The BCE submodel conforms to the DCA-P-92(R), Instructions for Reformatting the BCE/ICE, dated 15 May 84. This document contains instructions and definitions that were implemented to better explain Life Cycle Categories. The BCE document was designed to make it easier for cost analyst and program managers to identify, and quantify a particular cost category, and thereby achieve a better estimate of the total life cycle costs.

LCCAM has an interactive data entry option called the life cycle Cost Analysis Interactive Data Entry System (CAIDES). CAIDES is written in Fortran 77 and uses a question and answer format to prompt the user for the data to be entered. CAIDES then rearranges the data into a format which can be read by LCCAM. The data entered through CAIDES is permanently stored as the LCCAM data file.

CAIDES has a help feature. A full prompt version is available for inexperienced users and an abbreviated version is available for experienced users. CAIDES does allow the user to input data at consecutive sessions. After the user tells CAIDES that the data entry is complete, any changes to the LCCAM data file will have to be made through the system editor.

LCCAM also uses the "Namelist" method of inputting data. The "Namelist" specification is a feature of most Fortran compilers. It allows the user to enter data in batch mode format-free.

LCCAM also has a help feature called Life Cycle Help or (LCHELP). LCHELP explains to some extent the methodology used to accomplish each namelist category. LCHELP also provides the definitions of each variable used in a particular namelist.

NVEOC refers to LCCAM, LCHELP, and CAIDES as the Life Cycle Cost Analysis System (LCCAS). After all data have been entered through CAIDES, the user will be prompted to indicate if LCCAM will be executed. If the user answers yes, LCCAS will begin execution. If the user answers no, LCCAS will cause the computer to go back to regular operating mode.

E. BACKGROUND.

In 1970, the increase of complexity and cost of various programs created a need for an in-house cost analysis capability at CNVEO. By 1972, Life Cycle Cost and Risk Analysis for electro-optical systems were instituted.

The model was first used at CNVEO in Phase I Engineering Development Source Selection Evaluation for the Tube-Launched, Optically Tracked, Wire-Guided (TOW) Night Vision System. The model was later adopted by the project manager for the Remotely Monitored Battlefield Sensor Systems as an effective management tool.

In 1975, LCCAM was revised to increase its flexibility and to be used as a tool in the Phase II Source Selection Evaluation for the Infrared Night Vision Sight (AN/TAS-4) used with the TOW system.

The addition of the DA Pam submodel occurred in 1981. The BCE submodel was added in 1985. The addition of the BCE submodel to LCCAM stemmed from revised guidance from the Directorate of Cost Analysis, Office of the Comptroller of the Army. The new guidance was for the preparation of LCCBCE and ICE. The revisions for the BCE/ICE are documented in the Technical Report DCA-P-92(R), "Instructions for Reformatting the BCE/ICE," dated 15 May 84.

The NVEOC LCCAM is designed for use with EO/E systems, and can be used with some mechanical systems provided that the mechanical system is composed of removable and replacable components, and the failure rate of the mechanical system approaches that of the exponential distribution. LCCAM is ever evolving to meet the life cycle cost needs of the Army.

SECTION III. TECHNICAL EVALUATION.

A. DOCUMENTATION.

The mathematical model for LCCAM is documented in the NVEOL LCCAM Functional Description Part II, dated 5 Aug 83. The mathematical model describes the cost elements of DA Pam 11-2, 11-3, and 11-4, as well as the equations that correspond to each cost element. The methodology can be interpreted by one outside of the experienced cost analyst arena.

Other documentation are the NVEOL LCCAM CAIDES User's Manual, and NVEOL LCCAM summary of revised BCE format.

The CAIDES user's manual defines each namelist group and their associated variables. The user manual also documents the information contained in LCHELP. MRSA found the CAIDES user manual to be relatively easy to follow. Another document is the Interactive Data Entry System (IDES) User's Manual - Notes. IDES User's Manual Notes lists corrections to and additions for the CAIDES User Manual.

The LCCAM Summary of Revised BCE documents the procedure for setting up the data file and executing the BCE submodel. The documentation is in its draft stages. It contains the flags, cost centers, and variables that must be input to execute, and obtain the desired output for the BCE submodel. The LCCAM Summary of Revised BCE also contains the equations used to obtain the BCE costs. Each set of equations correspond to a specific cost element. For each set of equations, the corresponding DA Pam equation is also given. This allows the user to compare the difference between the DA Pam and BCE submodels costs. In some cases, there are no changes between the DA Pam and the BCE cost equations. The equations for the BCE submodel conform to the definitions for BCE as described and defined in the DCA-P-92(R), Instructions for Reformatting the BCE/ICE.

There is some discreprancy between the definitions of the variables contained in the documentation for the Mathematical Model and the LCCAM summary of Revised BCE documentation. MRSA contributes this discrepancy to the fact that the LCCAM summary of revised BCE documentation is in its draft stage. Overall, the documentation for LCCAM and LCCAS are easy to use. The data entry option is user friendly.

The instructions for setting up a data file for DA Pam model contained in LCCAM are easy to follow, and easy to implement. The instructions for setting up a data file for the BCE model contained in LCCAM are easy to follow but not as easy to implement.

NOTE: NVEOL, Nigh Vision and Electro-Optics Laboraratory; and NVEOC, Night Vision and Electro-Optics Center are synonymous to CNVEO, the Center for Night Vision and Electro-Optics.

B. INPUT REQUIREMENTS.

The input requirements for the revised BCE format are documented in the LCCAM Summary of Revised BCE Format. The summary assumes the user is familiar with the batch input procedure for the DA Pam submodel. The input procedure for LCCAM using the system editor is documented in the LCCAM User's Manual dated 5 Aug 83. The data files for the NVL and DA Pam submodels may be input through LCCAS, however the BCE data file cannot be entered. The BCE data file must be entered through the system editor. The NVL and DA Pam data files may also be entered through the system editor.

To execute the DA Pam submodel, ARFLAG, located in NAMELIST ADDON, should be set to 1. In NAMELIST RD, calculated values are linked to a key number corresponding to the cost center name entered in the data file by the user. For example, if the user enters values for the variables AENGMY (number of Advanced Development (AD) engineering man-years), and ADAVG (AD average cost per man-year), the model will calculate a value and print it out for an AD cost center with the key number 1.01.

To execute the BCE submodel, ARFLAG should be set to 2. The input procedure for the BCE submodel is the same as the input procedure for the DA Pam submodel. The numbering system for the cost elements are different than the DA Pam cost element numbering system, but the input procedure is the same. The default value for ARFLAG is zero. A zero value will cause a cost analysis run of the Night Vision Laboratory (NVL) submodel.

The NVL submodel input procedure for NAMELIST RD is different from the other two submodels. The NVL submodel will not be discussed in the TRA because it does not conform to present life cycle cost Army regulations.

LCCAM input procedure is divided into textual and unformatted namelist formats. Textual information may be the name of the system, modules, or numbers (flags). The textual information requires a specific format. Textual information is the first input data entered.

After the textual information is entered, all other inputs follow the unformatted namelist. Data may begin anywhere from columns 2-80. A comma must seperate each entry. Data may continue on successive lines, for as many lines as necessary. After each namelist group data, a $END should be input. $END may appear anywhere in columns 2-80. A comma must appear between the last name in the list and the $END.

When all the namelist data have been entered, a GO command is entered. The GO command starts in column 1. GO initiates a cost analysis run of the system.

When using LCCAS to input data, CAIDES prompts the user to enter data and namelist names. After all data have been input, CAIDES rearranges the data into the format above and saves the data file.

There are 22 namelists for LCCAM AND LCCAS. The following namelists and their definitions (taken from the NVEOL Life Cycle Cost Analysis Interactive Data Entry System User's Manual) are:

NAMELIST COST is used to enter cost data for each module by average unit-cost, quantity, module, learning curve, and learning breakpoint quantities.

NAMELIST CHAR is used to enter module and system characteristics, such as; mean time to repair (MTTR), mean time between failure, weight and spare parts cost for modules.

NAMELIST PRODCE is used to enter production and delivery data for the module. The data includes production rates for both module and system.

NAMELIST XSYSTM is used to load data on production schedules for common modules.

NAMELIST CONST is used to modify any of the nine different constant groups such as; life cycle, attrition rate, transportation factors, economic constants, and shipping. Some of the constant groups are standard values in the model. When using common modules, enter the data once in this namelist group.

NAMELIST DEPLOY is used to enter deployment schedule information.

NAMELIST OVERH is used to load information on the method of overhaul and its schedule.

NAMELIST SPECL is used to load Investment cost center information for selected modules, and identify modules affected, and year and number of cost centers affected.

NAMELIST GETTER is used to load data for systems that require periodic labor.

NAMELIST STORE is used to enter the number of systems stored each year.

NAMELIST POWER is used to enter miscellaneous data and the power source of the module/system. Source options are; battery, gas, cartridge, valve, and miscellaneous costs.

NAMELIST OPERAT is used to compile the maintenance and operations data, which include; turn-around time, maintenance float factors, operating hours, and system MTTR.

NAMELIST LOTBUY is used to enter data, by module, for multi-year module buy schedule matrix and the number of years for that purchase.

NAMELIST ADDON is used to add costs to existing cost centers and to input additional investment and operation and support cost centers.

NAMELIST INFL enters data used in the calculation of the cost escalation tables; fiscal year, inflation rate, and outlay rates for procurement.

NAMELIST PRIOR is used to enter data on the cost prior to the first fiscal year in the life cycle cost analysis and set R&D variables.

NAMELIST MULTPL enters data used in a sensitivity analysis.

NAMELIST CTRLBR enters data on contract costs into DA Form 633 categories; contractor profile G&A rate, and hourly rates.

NAMELIST OUTPUT is used to select the output formats.

NAMELIST RD is used to input variables used for R&D calculations in the DA Pam and BCE formats.

NAMELIST PEMA is used to enter data for PEMA calculations for the AR format. Variables include; engineering costs, testing, man-years, facilities, and training.

NAMELIST OMA is used to enter information to be used in the OMA calculations in the DA Pam and BCE formats.

LCCAM requires a significant amount of data to achieve credible results; however, this is true of any cost model that does not contain or access an extensive data base. The output product is only as good as the data entered. There are several sources of data. When performing a life cycle cost for a developmental EO/E system, data may be obtained from the contractor, a baseline comparison system, historical data, government system specifications, and best expert opinion. The CNVEO uses common EO/E system modules. Therefore, once data is acquired for one type module, that data will always be available. The inflation data is obtained from AMC. Some input variables have standard government furnished parameter values. These variables are used if system specific data is not available. These variables and their corresponding data values are listed in appendix B, Input Parameters.

C. OUTPUT PRODUCTS. After data have been input for a complete system, a TOTAL command is entered. TOTAL enables the program to sum the cost results of the system and print the results. An END command starting in column 1 lets the model know that all cost analyses have been run. LCCAM provide the following output summary reports:

LISTING OF INPUT DATA
INTERMEDIATE RESULTS
INVESTMENT COST DATA BY COST CENTER PER YEAR (AR OR NON AR REPORT)

O&S COST DATA BY COST CENTER PER YEAR (AR OR NON AR REPORT)
SUMMARY COST DATA BY COST CENTER
SUMMARY COST BY YEAR
LCCOST SUMMARY

Non-AR format refers to the NVL submodel. AR format refers to the DA Pam 11-2, 11-3, and 11-4 submodel. LCCAM organizes the output into an easy to read format. The intermediate results generated include learning curve characteristics, module maintenance float factors, maintenance float spares, and training requirements. LCCAM also generates PEMA and OMA cost data according to functional costs. The user controls the output format through the variables KIN, INTER, KSYS, and KOUT in namelist output. The life cycle cost summary is always printed.

The variable KIN causes LCCAM to output the data that was input. The variable INTER results in intermediate results being output. The variable KOUT causes the program results to be printed. The variable KSYS causes system and auxiliary system results to be printed.

The 61 cost elements of the DCA-P-92(R), Instructions for Reformatting the BCE/ICE, evolved from the 39 cost elements of DA Pams 11-2, 11-3, and 11-4. The major differences between the DA Pam and the BCE submodels lie in the resolution of the life cycle cost elements. While the DA Pam model is based on the R&D, investment, and operation and support phases, the BCE submodel calculations are resolved into five life cycle phases, i.e., R&D, Production, Military Construction, Fielding, and Sustainment.

In addition to the basic output summaries available, the BCE submodel presents output products in executive summary reports. The executive summary reports are output by:

CURRENT AND PRIOR YEAR
BUDGET YEAR
5 POM YEAR
TOC (TO COMPLETION)

D. USER TRAINING. Prospective users may request a training course from CNVEO. The course lasts 3-5 days and is designed to teach the prospective users how to set up the data file. The course also introduces the user to the computer system and computer language used at CNVEO.

E. APPLICABILITY TO MIL-STD-1388-1A. This section identifies all the tasks/subtasks found in MIL-STD-1388-1A to which LCCAM may be applied. Table III-1 can be used as a quick reference to identify the subtasks to which LCCAM may be applied, the life cycle phases during which the subtask is required and application of LCCAM is appropriate, and the extent to which the model satisfies the subtask. A brief remark pertaining to each subtask is also given in the table, but a more detailed description can be found below.

TURNAROUND TIME FOR REPAIR

TABLE III-1: LCCAM-LSA APPLICATION TABLE

TASK	APPLICABILITY BY LIFE CYCLE PHASE*	FULFILLMENT OF TASK (%)
203. COMPARATIVE ANALYSIS.		
203.2.3	H,C,D	85
203.2.5	H,C,D,F,P	70
205. SUPPORTABILITY AND SUPPORTABILITY RELATED DESIGN FACTORS.		
205.2.5	D	100
302. SUPPORT SYSTEM ALTERNATIVES.		
302.2.1	C,D	60
302.2.2	C,D,F,P	100
303. EVALUATIONS OF ALTERNATIVES AND TRADE-OFF ANALYSIS.		
303.2.1	C,D,F	60
303.2.3	C,D,F,P	85

*H - PRECONCEPT, C-CONCEPT, D- DEMONSTRATION AND VALIDATION, F-FULL SCALE DEVELOPMENT, P-PRODUCTION

TASK 203. COMPARATIVE ANALYSIS.

Subtask 203.2.3 - LCCAM estimates the operation and support cost of a comparative system. The RAM values are input directly into the model. LCCAM does not determine the readiness values. LCCAM provides an output of functional O&S costs for each cost element in DA Pam 11-4, Operating and Support Cost Guide for Army Systems.

Subtask 203.2.5 - LCCAM can identify the cost drivers through the sensitivity analysis feature. The variables on which sensitivity analysis can be performed most readily are the average unit cost per module, average learning curve, mean time between failure (MTBF) for modules, mean time between repair for modules, spare part costs, and all weights. Any other model input variables may be varied on successive runs and the results compared.

TASK 205 - Supportability and supportability related design factors.

Subtask 205.2.5 - Supportability and cost objectives can be obtained as the system becomes better defined.

TASK 302. SUPPORT SYSTEM ALTERNATIVES.

Subtask 302.2.1 - Given that new concepts are obtained, an alternative concept that reduces support cost may be identified. LCCAM provides the analyst or user with functional estimates of life cycle costs on a year-by-year basis, as well as an estimate of total life cycle costs. The analyst, by comparing costs and weighing alternative concepts costs against other concepts costs, is responsible for choosing the most viable concept. As an example, if the user is choosing the most viable system based totally on life cycle cost objectives, then the user will chose the concept with the least life cycle cost. If the user is choosing the most viable concept based on system specifications, design, performance, logistics, and life cycle costs, then the user will choose the concept that best meets desired system features at the minimum life cycle cost.

Subtask 302.2.2 - Updates to the alternative support concepts can be made as better information is obtained.

TASK 303. EVALUATION OF ALTERNATIVES AND TRADE-OFF ANALYSIS.

Subtask 303.2.1d - Sensitivity analyses can be performed on these variables: average unit cost, weight, spare part, MTBF, and MTTR for all modules.

Subtask 303.2.3 - LCCAM can be used to conduct trade-offs between design, operations, and support concepts under consideration. From the different cost outputs obtained from execution of LCCAM, the cost analyst compares the alternative concepts and chooses the most feasible alternative.

F. CALCULATIONS/EQUATIONS (DA PAM SUB-MODEL). The equations for each phase of the life cycle were analyzed and compared to DA Pam 11-2, 11-3, and 11-4 requirements. The equations follow those suggested in the DA Pams. Some of the equations were expanded to better reflect the total life cycle cost of that cost element. MRSA found the expansions of the equations to be a good attribute of the LCCAM methodology because the expanded equations allowed LCCAM to more closely model the real world. The DA Pams cost element equations that have been expanded are listed below.

1.0 Research and Development (R&D) Phase of the Life Cycle.

Seperate sections of inputs and outputs are provided for advanced development (AD) and engineering development (ED).

1.04 Prototype Manufacturing. Prototype manufacturing costs are calculated by multiplying the number of prototypes to be procured by the average unit cost of the items manufactured.

1.06 System Test and Evaluation. The equation was expanded to include a term for nonrecurring system test costs.

1.07 System Project Management. The equation was expanded to include the cost of a project manager.

1.10 Other. Two cost elements, 1.101 "Other Government" and 1.102 "Other Contractor" have been added.

2.00 Investment Phase of Life Cycle.

2.01 Nonrecurring Engineering. Although the DA Pam identifies nonrecurring engineering cost in the investment cost equation, a separate cost does not exist in the numbering system. LCCAM includes nonrecurring engineering cost as a component of Other Nonrecurring Costs.

2.04 System Test and Evaluation. Nonrecurring system test cost has been added.

2.06 System/Project Management. The system/project management equation has been expanded to include both the cost of project management and recurring engineering.

2.08 Training Services and Equipment. The equation has been expanded to include the cost of training instructors for maintenance personnel, and the cost of training the maintenance personnel.

2.10 Transportation Costs. The equation has been modified to reflect the actual maintenance concept of EO/E systems.

3.0 O&S Phase of the Life Cycle.

3.052 Other Direct Costs. Other direct costs are calculated using depot inventory holding and miscellaneous costs.

G. CALCULATIONS/EQUATIONS (REVISED BCE SUBMODEL).
The DCA-P-92(R), Instructions for Reformatting the BCE/ICE, contains no equations. Rather, the document contains definitions of the 61 cost elements that resulted from the redefinition and resolution of the 39 cost elements of DA Pam 11-2 through 11-4. Other than the deletion of DA Pam cost elements 3.062 Transients, Patients, and Prisoners, and 3.064 Medical Support, there are no changes between the overall cost content, between the DA Pam model, and the BCE model. The equations used for the BCE submodel are the same as the equations of the DA Pam submodel except where the definition of a cost element conflicts with that of the DCA-P-92(R), Instructions for Reformatting the BCE/ICE. Below are listed the cost elements of the DCA-P-92(R) document that have been redefined, their funding category, and the variables used in LCCAM equations to calculate the cost according to the definitions of the DCA-P-92(R), Instructions for Reformatting the BCE/ICE.

1.0 Research and Development

1.03 System Test and Evaluation (AD), System Test and Evaluation (ED). This cost element is the percent of AD and ED system test and evaluation that is RDT&E funded. The user achieves this cost by inputting the percent that is RDT&E funded through the variable RDTEST in NAMELIST RD.

1.05 Training, Services, and Equipment. This cost element is the percent of training, services, and equipment that is RDT&E funded. This percent is input in NAMELIST RD. The variable used to input the percentage is RDTETR.

1.06 Facilities (contractor), Facilities (government). This cost element is the percent of contractor and government facilities cost that is RDT&E funded. This percentage is specified through the variables RDTEFC (contractor) and RDTEFG (government) located in NAMELIST RD.

2.0 Production.

2.011 Initial Production Facilities. This cost element is separately identified. It is a variable in DA Pam 2.01 Non-Recurring Investment. Therefore, no special variable should be entered for the revised BCE submodel to calculate this cost.

2.012 Production Base Support. This cost element is the amount of production base support that is procurement funded. This percentage can be allocated through the variable PROCON located in NAMELIST PEMA.

2.014 Other Nonrecurring Production. This cost element is the sum of nonrecurring engineering cost plus other nonrecurring production throughput costs.

2.022 Recurring Engineering. This cost element has been redefined to identify the cost of recurring engineering between government and contractor as a function of year.

These next three cost elements are the percent of costs that are procurement funded. The variables that help accomplish this cost fund category and the corresponding namelist are listed.

2.05 System Test and Evaluation (PROSTE; NAMELIST PEMA).

2.06 Training, Services, and Equipment (PROTSE; NAMELIST PEMA).

2.08 Operational/Site Activation (PROSA; NAMELIST PEMA).

2.07 Initial Spares. Cell 2.07 reflects the procurement funded/ initial spares portion of DA Pam element 2.09.

2.09 Other Procurement Funded Production. This cost element is a component of DA Pam elements 2.025 (Other Production Costs); 2.11 (the procurement funded portion of Other Investment costs); and, the Government portion of system/project management.

3.0 Military Construction.

These next three costs are the fraction of costs that are Military Construction Army (MCA) funded.

3.01 Test Construction. For cost element 1.06, the user specifies the percentage of contractor and government facilities that are RDT&E funded through the variables RDTEFC (percent of contractor RDT&E facilities costs), and RDTEFG (percent of government RDT&E facilities costs), the remainder is MCA funded and is listed in this cost element.

3.02 Production Construction. The variable CONREL(I) is used to allocate the amount of real-estate cost that is MCA funded, depending upon the fraction of cost entered for PROCON (the fraction of procurement-funded costs). For example, if the user enters 1.0 for PROCON, then the model assumes 100 percent procurement funding, and assigns none of the cost of production construction to MCA funding.

3.03 Operation/Site Activation Construction. The fraction of operation/site activation construction cost that is MCA funded is input through the variable MCAF.

3.04 Other MCA Funded Construction. The fraction of DA Pam cost element 2.07 that is not defined by either procurement variable PROSA or the MCA variable MCAF.

4.0 Fielding.

4.01 System Testing and Evaluation. Cost element 4.01 is composed of the O&M funded amount of PEMA system test and evaluation, and the O&M funded portion of R&D system test and evaluation. The entries for the variables OMSTE(the percentage of system test and evaluation that is O&M funded), & PROSTE(the percentage of system test and evaluation that is procurement funded) determines the percent of system testing and evaluation that is O&M funded. The percentages should be input in NAMELIST OMA and PEMA respectively.

4.02 Training Services and Equipment. This cost element is the sum of the O&M funded amount of DA Pam element 1.08 (training) and the O&M funded amount of DA Pam element 2.08 (training). The user specifies the percent of R&D training that is O&M funded through the variable OMRTSE. This corresponds to DA Pam element 1.08 (training). The user specifies the percent of production training that is O&M funded through the variable OMPTSE. This corresponds to DA Pam element 2.08 (training). These variables are input in NAMELIST OMA.

4.04 Initial Repair Parts, O&M Funded. This cost element is formulated from the initial repair part of DA Pam element 2.09,

Initial Spares and Repair Parts. LCCAM requires no special input variable to accomplish the cost calculation.

4.06 Other O&M Funded Fielding. This cost element is the amount of other investment cost that is O&M funded. The percent of other operation and maintenance funding for the field depends on the input value for PROTHO located in NAMELIST PEMA. If the user enters .40 for PROTHO, the model assumes that 40 percent of the funding is procurement and the remaining 60 percent is the amount of other investment costs that are O&M funded.

5.0 Sustainment.

5.011 Replacement Repair Parts, O&M Funded. This cost element is the O&M funded amount of replacement spares. The variable OMRSP (the percentage of replenishment spares that are O&M funded) is used to input the O&M funded portion of replacement spares. This cost element is input in NAMELIST OMA.

5.012 Replenishment Spares, Procurement Funded. This cost element is the fraction of replenishment spares costs that are procurement funded. The cost of replacement spares that are procurement funded is obtained from the total cost of replacement spares minus the cost of OMA funded replenishment spares.

5.032 War Reserve Ammunition/Missiles. This cost element isolates the reserve ammunition/missiles component of DA Pam 3.065, Other Indirect Costs. All values entered for cost element 5.032 are throughput. The value entered by the user will be the value that is output.

These next two cost elements are the O&M funded portion and the procurement funded portion of depot maintenance. The percent value entered for OMDMM (NAMELIST OMA) determines the amount that is OMA funded and PRODMM (NAMELIST PEMA), determines the amount that is procurement funded.

5.042 Depot Maintenance Materiel (O&M Funded).

5.043 Depot Maintenance Materiel (Procurement Funded).

5.06 Transportation. This cost element is formulated from the revised BCE/ICE redefinition of DA Pam element 3.033, Depot Maintenance Transportation.

These next two cost elements are the procurement funded and O&M funded fraction of system-specific replacement costs. The variable PRSSR and OMSSR determines how the percentage will be allocated. PRSSR corresponds to the procurement funded cost and is input in NAMELIST PEMA. OMSSR corresponds to the operation and maintenance funded cost and is input in NAMELIST OMA.

5.071 System-Specific Replacement (Procurement Funded).

5.072 System-Specific Replacement (O&M Funded).

5.084 Trainer/Trainee Pay and Allowances. This cost element is the amount of personnel replacement that is neither procurement nor O&M funded. The LCCAM calculates this percentage by adding the percents entered for OMSSR and PRSSR and then subtracting the sum from one. The sum of OMSSR and PRSSR cannot exceed one.

5.085 System/Project Management Pay and Allowances. This cost element isolates the cost of military personnel in government system/project management. The user must specify two input variables in order for this cost element to be calculated: NGMIL (percentage of government system/project management cost that is associated with the military - from DA Pam cost element 2.06) and NMIL(I), (the number of military man-years required to complete a project by year - from DA Pam cost element 1.07).

5.087 Other MPA-Funded Sustainment. This cost element is the summation of the MPA funded part of DA Pam elements 1.06, System Test and Evaluation; 1.08, Training, Services, and Equipment; 2.08, training; 3.052, Other Direct Support Operations; and 3.065, Other Indirect Support Operations.

5.09 System Project Management Civilians. This cost element is the O&M funded cost of civilians assigned to the system project management office. The user must input values for two variables: NCIL(I), the number of civilian man-years associated by year with the system project management office (from DA Pam cost element 1.07), and NGMIL the percentage of government system/project management cost that is associated with the military (from DA Pam cost element 2.06).

H. COMPUTER EXECUTION/PECULIARITIES. MRSA experienced a storage problem with LCCAS. MRSA found that the University of Kentucky only allocated 2048k of storage to the users of the computer system. Therefore, the 2500k of storage required to execute LCCAM through LCCAS was a limitation.

The storage problem was dissolved when MRSA wrote a job control language that executed only LCCAM, not LCCAS. Remember that LCCAS contains LCCAM, CAIDES, and LCHELP. The new job control language allowed the user execution of LCCAM in batch mode.

MRSA found that LCCAS could still be used to enter the data file. This was found to be a good feature because of the large amount of data that had to be input.

After the user has completed entering data through LCCAS, he is prompted to answer the question, DO YOU WANT TO EXECUTE LCCAM?. The user must enter no if the computer system does not allocate 2500k of storage; otherwise, the storage capacity of the system will be exceeded. The data file will still exist.

While creating the data file through LCCAS, MRSA found the following errors within the interactive data entry option, CAIDES:

NAMELIST	VARIABLE(s)	EXPLANATION
CONST	AR & ZSPAR	These variables are not valid inputs because they were omitted from the CAIDES source coding.
INFL	(3)INFLATION RATES & (4)ESCALATION FACTORS	Number three should be number four and vice versa.
RD	MAPRO	To make this a valid input, spell it correctly.
	MAREF, APTFUC, MEPRO, MEREF,	These variables were omitted from the CAIDES source coding.
PEMA	NUMPY	Is spelled NUMP in model. To make valid, spell correctly.

I. STRENGTHS AND LIMITATIONS.

STRENGTHS. LCCAM allows one to choose from three submodels and various output summaries. LCCAM methodology considers module and component commonality. The use of the same type module in systems reduces the unit cost of each module through cost savings due to factors such as common production facilities and tooling, maintenance facilities, and versatility of training. The model can perform maintenance at DS, GS, Depot, or any combination. The interactive data entry system is one of the models strengths because for the user with little experience with LCCAM, CAIDES significantly reduces the time required to input the data. Also, the interactive data entry system is a strength because it does not require knowledge of the batch input method.

When inputting data through the system editor, LCCAM accepts a maximum of 45 years of life cycle cost, 30 modules per subsystem, and 99 subsystems and auxiliary systems.

LIMITATIONS. When inputting the data through CAIDES, LCCAS accepts a maximum of four auxiliary systems and thirty years of life cycle cost. After all data have been entered through CAIDES, changes cannot be made. The user must make changes to the data file through the system editor.

For the three level maintenance concept of LCCAM - GS, DS, and Depot - the only parts replaced below depot are field throwaways; and no maintenance is performed by the soldiers in the field.

To acquire all the data needed for execution of LCCAM can be time consuming and requires a technical knowledge of the system under study.

The 2500k of storage required to execute LCCAS in the interactive environment may be a limitation for those users whose computer systems do not allocate that amount of storage.

Calculations of initial spares, repair parts, and system maintenance floats are based upon expected value rather than operational availability or confidence level.

J. CONCLUSIONS/RECOMMENDATIONS.

MRSA concludes that LCCAM is an effective technique for estimating life cycle cost of electronic and electro-optical systems. The technique can be used in the Demonstration and Validation and the Full Scale Development phases of the life cycle. LCCAM is also useful during the production phase. The model is a good tool for performing trade-off analysis, and can also be used for effective management.

The DA Pam submodel can also be used for early estimates of operation and support costs. The greatest influence on life cycle costing must be made early in the acquisition process when there is little available information about the proposed system or how it operates. Although early estimates of operation and support costs will not be accurate, they may be used as a baseline for design to cost, life cycle cost objectives, and as an effective management tool.

The NVEOC revised BCE submodel has not been fully tested. The documentation for the BCE submodel is in the draft form. MRSA agrees with the proponent of LCCAM that the revised BCE submodel should be fully tested before widespread distribution. MRSA recommends that the size of LCCAM be reduced in order to decrease the amount of storage needed to execute the model. This could be accomplished by letting the BCE submodel stand alone as a seperate technique.

MRSA also recommends that for logistic purposes the proponent should add to LCCAM the capability to calculate operational availability. Operational availability should be calculated according to AR 702-3 Army Materiel Systems Reliability, Availability, and Maintainability dated 1 May 1982.

Prospective users of LCCAM will be issued a slightly different computer version than was tested by MRSA. The version of LCCAM tested by MRSA did not include the BCE submodel with LCCAS. The computer version that will be given to prospective users will include the BCE submodel within LCCAS. This will enable the user to enter data through LCCAS for all submodels.

MRSA concludes that LCCAM is a good model for estimating life cycle costs of electronic systems using the DA Pam submodel.

APPENDIX A
EQUATIONS
THE DA PAM SUBMODEL

1.0 Research and Development

1.01 Development Engineering

```
ADRDC (1,I)      =  ((ADAVG*AENGMY)/100)*ADPCNT(I,NACNTR(1))
EDRDC (1,I)      =  ((EDAVG*EENGMY)/100)*EDPCNT(I,NECNTR(1))
```

ADAVG = AD average cost per man-year.
AENGMY = Number of AD engineering man years.
ADPCNT(I,NACNTR(1)=Percentage of total AD cost per year and cost center.
ADRDC (1,I) = AD development engineering cost by year.

EDAVG = ED Average cost per man-year.
EENGMY = Number of ED engineering man-years.
EDPCNT(I,NECNTR(1))= Percentage of total ED cost per year and cost center.

EDRDC(1,I) = ED development engineering cost by year.

I = Index to account for the variation of costs as a function of year.
NECNTR(1) = Flag to indicate position of development engineering in the input file.
NANCTR(1) = Flag to indicate position of development Engineering in the input file.

1.02 Producibility Engineering and Planning

```
EDRDC(2,I)       =  ((EDPEP*EDTRD(I))/(1-EDPEP))
```

EDRDC(2,I) = Producibility engineering and planning cost factor by year.
EDPEP = Producibility and engineering cost factor.
EDTRD(I) = Total system development cost per year.

1.03 Tooling

```
EDRDC(3,I)       =  EDAMT(I,NECNTR(3))
```

EDRDC(3,I) = Tooling cost by year.
EDAMT(I,NECNTR(3))= Full scale engineering cost by year and cost center.

1.04 Prototype Manufacturing

```
ADRDC(4,I)       =  (ATOTPR/100)*ADPCNT(I,NACNTR(4))
EDROC(4,I)       =  (ETOTPR/100)*EDPCNT(I,NECNTR(4))
```

ADRDC(4,I) = AD prototype manufacturing cost by year.
ATOTPR = AD total prototype manufacturing cost.

```
ADPCNT(I,NACNTR(4)) = Percentage of total AD cost per year and
                      cost center.
EDRDC(4,I)       =  ED prototype manufacturing cost by year.
ETOTPR           =  ED total prototype manufacturing cost.
EDPCNT(I,NECNTR(4)) = Percentage of total ED cost per year and
                      cost center.
```

1.05 Data

```
ADRDC(5,I)       =  ADTRD(I)*ADATA
EDRDC(5,I)       =  EDTRD(I)*EDATA

ADRDC(5,I)       =  AD data cost by year.
ADATA            =  AD data cost factor.
ADTRD(I)         =  AD total system development cost by year.

EDRDC(5,I)       =  ED data cost by year.
EDATA            =  ED data cost factor.
EDTRD(I)         =  ED total system development cost by year.
```

1.06 System Test and Evaluation

```
ADRDC(6,I)       =  ((ADTEST*ADNTST)+ADNONR/100)*
                     ADPCNT(I,NACNTR(6))
EDRDC(6,I)       =  ((EDTEST*EDNTST)+EDNONR/100)
                      *EDPCNT(I,NECNTR(6))

ADRDC(6,I)       =  AD system test and evaluation cost by year.
ADTEST           =  AD cost per test period.
ADNTST           =  Number of AD test periods.
ADNONR           =  AD nonrecurring test, and evaluation cost.
ADPCNT(I,NACNTR(6))= Percentage of total AD program cost by cost
                     center and year.

EDRDC(6,I)       =  ED system test and evaluation cost by year.
EDTEST           =  ED cost per test period.
EDNTST           =  Number of ED test periods.
EDNONR           =  ED nonrecurring test and evaluation cost.
EDPCNT(I,NACNTR(6))= Percentage of total ED program cost by cost
                    center and year.
```

1.07 System/Project Management (Contractor)

```
ASPM(I)          =  (ADCSPM*ADCPMY/100)*ADPCNT(I,NACNTR(7))+ACAMT
ESPM(I)          =  (EDCSPM*EDCPMY/100)*EDPCNT(I,NECNTR(7))+ECAMT

ASPM(I)          =  AD contractor system/project management by
                    year.
ADCSPM           =  AD cost of contractor system/project
                    management.
ADCPMY           =  AD contractor project management man-years.
ADPCNT(I,NACNTR(7))= Percentage of total AD program cost by
                     year and cost center.
ACAMT            =  AD contractor amount.
```

ESPM(I) = ED contractor system/project management by year.
EDCSPM = ED cost of contractor system/project management.
EDCPMY = ED contractor project management man-years.
EDPCNT(I,NACNTR(7))= Percentage of total AD program cost by year and cost center.
ECAMT = ED contractor amount.

1.07 System/Project Management (government)

ADRDC(7,I) = [{PMF*SAL1}+{ADGPMY*SAL1}]/100 *ADPCNT(I,NACNTR(7)]
EDRDC(7,I) = [{PMF*SAL1}+(EDGPMY*SAL1}]/100 *EDPCNT(I,NECNTR(7))

ADRDC(7,I) = AD government system/project management.
PMF = Equivalent number of program management man-years needed.
ADGPMY = AD government project management man-years.
SAL1 = Yearly cost of a program manager.
ADPCNT[I,NACNTR(7)= Percentage of total AD program cost by cost center and year.

EDRDC = ED government system/project management.
EDGPMY = ED government project management man-years.
EDPCNT(I,NACNTR(7))= Percentage of total ED program cost by cost center and year.

1.08 Training, Services, and Equipment

EDRDC(8,I) = (((EDMYR*EDAVG)+EDNTR*EDEQ))/100 *EDPCNT(I,NECNTR(8))

EDRDC(8,I) = ED training cost by year.
EDMYR = ED number of man-years for equipment design and training.
EDAVG = ED average cost per man-year.
EDNTR = ED number of training sets.
EDEQ = ED average cost per equipment set.
EDPCNT(I,NECNTR(8))- Percentage of total ED program cost by cost center and year.

1.09 Facilities (Contractor)

CNTFAC(I) = CNTFAC(I)+EDAMT(I,JJ)

CNTFAC(1) = Cost of contractor facilities by year.
EDAMT(I,JJ) = Throughput costs by year and cost center.

1.09 Facilities (Government)

EDRDC(9,I) = EDAMT(I,JJ)

EDRDC(9,I) = ED facilities cost by year.

EDAMT(I,JJ) = Full-scale ED engineering cost by year and cost center.

1.10 Other Research and Development (Contractor)

ADRDC(10,I) = ADAMT(I,JJ)

ADRDC(10,I) = Other AD contractor cost by year.

ADAMT(I,JJ) = Other AD contractor cost by year and cost center (throughputs).

JJ = Index to account for variation in cost as a function of cost center.

EDRDC(10,I) = EDAMT(I,JJ)

EDRDC(10,I) = Other ED contractor cost by year.

EDAMT(I,JJ) = Other ED contractor cost by year and cost center (throughputs).

1.11 Other Research and Development (Government)

ADRDC(11,I) = ADAMT(I,JJ)

ADRDC(11,I) = Other AD government cost by year.

ADAMT(I,JJ) = Other AD government cost by year and cost center (throughputs).

JJ = Index to account for variation in cost as a function of cost center.

EDRDC(11,I) = EDAMT(I,JJ)

EDRDC(11,I) = Other ED government cost by year.

EDAMT(I,JJ) = Other ED government cost by year and cost center.

1.0 Research and Development

TRDC $= \sum_{I=1}^{R} \mathrm{RDC}(I)$

TRDC = Total R&D cost.

RDC(I) = R&D cost for all fiscal years from the first year I=1 to the last year, R.

2.0 Investment Phase

2.01 Nonrecurring Investment

ARPC(1,I) = ANRENG(I)+AIPF(I)+BSC(I)

ARPC(1,I) = Nonrecurring investment cost by year.

ANRENG(I) = Nonrecurring engineering cost by year.

AIPF(I) = Initial production facilities cost by year.

BSC(I) = Production base support cost by year

2.02 Production Cost

PCOST	=	[SP(I)*NMS(IS)*AUCY(I,IS)*COMP(I)] +[(SAL4*NUMPY(I))+SCC(I,J)] +[QCONST*NPY(I)]
SP(I)	=	Number of systems procured each year.
NMS(IS)	=	Quantity of each module per system.
AUCY(I,IS)	=	Average unit cost of each module for each year.
SAL4	=	Yearly salary of a contractor.
NUMPY(I)	=	Number of man-years of PEMA recurring engineering by year.
COMP(I)	=	Competition factor applied to Average Unit Cost by year.
SCC(I,J)	=	Tooling throughput costs for each module by year.
QCONST	=	Quality control cost per man-year.
NPY(I)	=	Number of quality control man-years by year.

2.03 Engineering Changes

ARPC(3,I)	=	ECCF(I) + C(3,I)
ARPC(3,I)	=	Cost of engineering change orders by year (DA Pam).
C(3,I)	=	Hardware cost by year.
ECCF(I)	=	Engineering change order cost factor by year.

2.04 System Test and Evaluation

ARPC(4,I)	=	[STEST*NTP(I)]+NRSYST(I)
ARPC(4,I)	=	Cost of system test and evaluation.
STEST	=	System test cost by year.
NTP(I)	=	Number of test periods by year.
NRSYST(I)	=	Nonrecurring system test cost by year.

2.05 Data

ARPC(5,I)	=	(ARPC(K,I)*DATACF(I)) where K = 5
ARPC(5,I)	=	Cost of Data.
K	=	Index to account for variation of cost as a function of cost center.
DATACF(I)	=	Data cost factor applied to all other investment costs by year.

2.06 System Project Management

ARPC(6,I)	=	C(9,I) + (NGMYR(I) * SAL1) + (NCMYR(I) * SAL4)
ARPC(6,I)	=	System/project management cost by year.
C(9,I)	=	Cost of government system management by year.

NGMYR(I) = Number of government man-years by year.
NCMYR(I) = Number of contractor man-years by year.
SAL1 = Annual salary of a government project manager.
SAL4 = Annual salary of a contractor project manager.

2.07 Operational/Site Activation

ARPC(7,I) = REALC(I) +FACC(I) +COSC(I)

ARPC(7,I) = Operational/site Activation Cost by year.
REALC(I) = Real estate cost by year.
FACC(I) = Facilities cost by year.
COSC(I) = Check-out services cost by year.

2.08 Training Services and Equipment

ARPC(8,I) = (TRAINC(I)*NMYRTR(I)) + (EQUIPC*NEQUIP(I)) + (SCF(I) *EQUIPC*NEQUIP(I) + TRFC(I))

ARPC(8,I) = Cost of training by year.
TRAINC(I) = Training cost per man-year by year.
NMYRTR(I) = Number of man-years of training by year.
EQUIPC = Cost per equipment set.
NEQUIP(I) = Number of equipment sets by year.
SCF(I) = Spares cost factor by year.
TRFC(I) = Training facility cost by year.

2.09 Initial Spares and Repair Parts

ARPC(9,I) = [(XSPAR(I,LS)*NMMF(I,IS))* AUCY(I,IS)] + [AUCY(I,IS) *NSPAR(I,IS)]

ARPC(9,I) = Cost of initial spares and repair parts by year.
AUCY(I,IS) = Average unit cost of each module for each year.
NMMF(I,IS) = Number of maintenance module floats by year and module.
NSPAR(I,IS) = Number of maintenance module floats by year and module.
XSPAR(I,IS) = Money pool for replacement parts for each module by year.

2.10 Transportation

There are four options. Which option the model utilizes depends on the variables input. The options along with the associated variable are as follows:

Option
1 - C(8,I) = TF1*(C(3,I) + C(6,I))
2 - C(8,I) = FDTR*WEIGHT*SP(I)*(1+SMFF+DMFF)

3 - C(8,I)	=	T*SP(I)+TFAC*DEF(I)*(C(6,I)+C(3,I))
4 - C(8,I)	=	XSUM+ZSUM+ASUM+SYS

Option	Input variables
1	No special input
2	FDTR
3	RPD,RPDS,RDSB,RDSD
4	RPD,RDGS,RGSDS,RDIRSB

ARPC(10,I) = C(8,I)

ARPC(10,I)	=	Transportation cost.
ASUM	=	Piece parts from plant to Depot.
C(3,I)	=	Cost of hardware.
C(6,I)	=	Cost of maintenance float.
C(8,I)	=	Cost of initial transportation.
DEF	=	Calculated factor of production deployed each year.
DMFF	=	Module maintenance float factor.
FDTR	=	Initial transportation rate.
RDGS	=	Transportation rate from Depot to GS.
RDIRSB	=	Transportation rate from DS to base (user).
RDSB	=	Transportation rate from DS/GS to base.
RGSDS	=	Transportation rate from GS to DS.
SMFF	=	System maintenance float factor.
SP(I)	=	Number of systems procured by year.
SYS	=	Original system cost from plant to user.
TFAC	=	Percentage of hardware costs allocated to transportation for packing.
TF1	=	Initial transportation factor.
WEIGHT	=	Shipping weight of total system.
XSUM	=	System float from plant to AVUM.
ZSUM	=	Module float from plant to AVIM.
RPD	=	Transportation rate, plant to Depot.
RPDS	=	Transportation rate, plant to DS/GS.
RDSD	=	Transportation rate from DS/GS to Depot.
T	=	Calculated factor of system and maintenance float weights and transportation rates.

2.11 Other Investment Costs

ARPC(11,I) = CA(I,J)

ARPC(11,I)	=	Investment cost.
CA(I,J)	=	Throughput costs by year.

2.0 Investment cost

$$TIC = \sum_{I=1}^{P} IC(I)$$

TIC	=	Total investment cost.
IC(I)	=	Summation of the investment cost for all fiscal years from the first year, I=1, to the last year, P.

3.0 OPERATION AND SUPPORT COST

3.01 Military Personnel Cost

Crew Pay and Allowances, Maintenance Pay and Allowances, Indirect Pay and Allowances, and Permanent Change of Station are included in Military Personnel cost. The equations for each of the costs are presented below:

3.011 Crew Pay and Allowances

AROC(2,I) = SD(I)*NCREW*(CRPAY+TRCREW+FLGHTC)

AROC(2,I)	=	Crew pay and allowances by year.
CRPAY	=	Average annual base pay and allowances per crewman.
FLGHTC	=	Average annual flight pay per crewman.
NCREW	=	Number of crewmen per operational equipment.
SD(I)	=	Systems deployed by year.
TRCREW	=	Average annual theatre cost per crewman.

3.012 Maintenance Pay and Allowance

AROC(3,I) = SD(I)*NOMM*(MNTPAY+TRMNT+FLGHTM
if MNTPAY, TRMNT, and FLGHTM all equal to zero, then AROC(3,I) = C(14,I)

C(14,I) = CD(1,I)+CD(2,I)+CD(3,I)

AROC(3,I)	=	Maintenance pay and allowance.
C(14,I)	=	Field labor.
CD(1,I)	=	Trouble shooting labor.
CD(2,I)	=	Cartridge-charging labor.
CD(3,I)	=	Battery-charging labor.
FLGHTM	=	Average annual flight pay per maintenance man.
NOMM	=	Number of maintenance men required for training.
SD(I)	=	Number of systems deployed for year.
TRMNT	=	Average annual theatre cost per maintenance man.
MNTPAY	=	Average annual base P&A per maintenance person.

3.013 Indirect Pay and Allowances

AROC(4,I) = SD(I)*NOM2*(SAL6+TRINDR)

AROC(4,I)	=	Indirect pay and allowances by year.
NOM2	=	Number of indirect men per operational equipment.
SAL6	=	Average annual base pay and allowances per indirect man.
SD(I)	=	Number of systems deployed for year.

TRINDR	=	Average annual theatre cost per indirect man.

3.014 Permanent Change of Station

AROC(5,I) = SD(I)*NPERS*PSAVG

AROC(5,I)	=	Permanent change of station by year.
NPERS	=	Total number of personnel per equipment.
PCSAVG	=	Average annual PCS cost per man.
SD(I)	=	Number of systems deployed for year.

3.02 Consumption

3.021 Replenishment Spares

AROC(7,I) = CD(4,I)+CD(5,I)+CD(6,I)+CD(9,I).

AROC(7,I)	=	Replenishment spares by year.
CD(4,I)	=	Valve replacement cost by year.
CD(5,I)	=	Cartridge replacement cost by year.
CD(6,I)	=	Battery replacement cost by year.
CD(9,I)	=	Other consumables costs by year.

3.022 Petroleum, Oils, and Lubricants

AROC(8,I) = SD(I) * ACTPOL * PMILE

AROC(8,I)	=	Petrolem, oils, and lubricants by year.
SD(I)	=	Number of systems deployed by year.
ACTPOL	=	Annual activity rate per equipment(miles/year).
PMILE	=	Petroleum, oils, and lubricant cost per mile.

3.023 Unit Training, Ammunition, and Missiles

AROC(9,I) = SD(I) * AMCST

AROC(9,I)	=	Unit training, ammunition, and missiles.
AMCST	=	Annual ammunition/missile cost per equipment.
SD(I)	=	Number of systems deployed for year.

3.03 Depot Maintenance

3.031 Depot Maintenance Labor

AROC(11,I) = TSUM + CD(8,I) + CD(11,I)

AROC(11,I)	=	Depot Maintenance Labor by year.
TSUM	=	Cost of maintenance labor by year.
CD(8,I)	=	Cost of checkout labor by year.
CD(11,I)	=	Cost of overhead labor by year.

3.032 Depot Maintenance Materiel

AROC(12,I)	=	C(18,I) +CD(12,I)

AROC(12,I)	=	Depot maintenance materiel by year.
C(18,I)	=	Cost of depot materiel replacement parts by year.
CD(12,I)	=	Overhaul material by year.

3.033 Depot Maintenance Transportation

AROC(13,I)	=	C(20,I) + CD(13,I)

AROC(13,I)	=	Depot maintenance transportation by year.
C(20,I)	=	Depot repair transportation by year.
CD(13,I)	=	Depot overhaul transportation by year.

3.04 Modifications, Materiel Costs

AROC(14,I)	=	(SD(I) *C(3,I) * MODFAC(I,J)

AROC(14,I)	=	Modifications, materiel by year.
SD(I)	=	Number of systems deployed by year.
C(3,I)	=	Cost of hardware per year.
MODFAC(I,J)	=	Average annual modification factor by year and module.

3.05 Other Direct Support Operations

3.051 Depot Maintenance Civilian labor by year

AROC(16,I)	=	SD(I) * NCIV(I) * CIVCST

AROC(16,I)	=	Depot maintenance civilian labor by year.
NCIV(I)	=	Number of civilian maintenance persons by year.
CIVCST	=	Average annual cost per civilian maintenance person.

3.052 Other Direct Costs

AROC(17,I)	=	CD(7,I) + CB(I,K)

AROC(17,I)	=	Other direct costs.
CB(I,K)	=	Throughput costs.
CD(7,I)	=	Inventory holding costs by year.

3.06 Indirect Support Operations

3.061 Personnel Replacement

AROC(19,I)	=	C(13,I)

AROC(19,I)	=	Personnel replacement by year.
C(13,I)	=	Cost of replacement training by year.

C(13,I) = RTR * NRM(I) * CC * SUF

RTR = Replacement training rate factor.
NRM(I) = Number of repairmen needed by year.
CC = Training course cost.
SUF = Factor indicating the sharing of repairmen with other system.

3.062 Transients, Patients and Prisoners Costs.

AROC(20,I) = TPPFAC(I) * [CREWPA(I) + MPA(I) + IPA(I)]

AROC(20,I) = Transients, patients and prisoners costs in fiscal year I.
TPPFAC(I) = Transients, patients and prisoners factor in fiscal year I.

CREWPA(I) = Crew pay and allowances.
MPA(I) = Maintenance pay and allowances.
IPA(I) = Indirect pay and allowances in fiscal year I.

3.063 Quarters, Maintenance, and Utilities

AROC(21,I) = SD(I) * NPERS * QTRCST

AROC(21,I) = Quarters, Maintenance and Utilities.
SD(I) = Number of systems deployed.
NPERS = Number of military persons per equipment.
QTRCST = The average annual cost per person for quarters, maintenance, and utilities.

3.064 Medical Support

AROC(22,I) = SD(I) * NPERS * AVGMSC

AROC(22,I) = Medical support cost in fiscal year I.
SD(I) = Number of systems deployed.
NPERS = Number of military persons per equipment.
AVGMSC = Average annual medical support cost per person.

3.065 Other Indirect Costs

AROC(23,I) = C(17,I) + CB(I,K) + CDCONT(I)

AROC(23,I) = Other indirect supports by year.
CB(I,K) = Throughput cost.
C(17,I) = Cost of non-standard parts management by year.
CDCONT(I) = Cost of transporting replenishment spares by year.

APPENDIX B
Input Parameters

TABLE B-1 is a list of standard input variables used in LCCAM. Also, listed below are government furnished parameter values. These values are used by CNVEO if system-unique information is not available. Variables are expressed in FY86 constant dollars where applicable.

TABLE B-1: STANDARD INPUT VARIABLES

LCCAM INPUT	LCCAM INPUT DEFINITION	INPUT FACTOR
AR	Attrition Rate	1% Per Year
NFYP	Starting Year of Analysis	1986
NEL	Economic Life of System	15 years
	TRANSPORTATION RATE:	
RPD	Plant to Depot	$0.538/LB
RDGS	Depot to GS	$1.0201/LB
RDSGS	GS to DS	$0.0245/LB
RDIRSB	DS to User	0
WHRS	Working hours/Year for DS/GS Repairman	1806 Hours
NOMM	Number of DS/GS Repairmen required	132
PMF	Government Man Years per year to Manage Contract	2
RTR	Replacement Training Factor/Yr	0.333
SUF	Factor for Sharing DS/GS Repairmen with other Programs	1(no sharing)
CC	Training Cost Per DS/GS Repairmen	$12,516
SAL1	Government Cost/Man-Year for Contract Managers & Engineers	$114K
SAL2	Depot Labor Rate/Hr	$38.39
SAL3	DS/GS Labor Rate/Hr	$16.31
SHF	System Inventory Holding Factor	1%
SMHF	Module Inventory Holding Factor	3%
CILS1	Cost/New part to Enter ILS System	$975
CILS2	Cost/New Part to Keep in ILS System	$463
DEPER	(Fraction of Delivered Systems Deployed)/Stored	0.9/0.1
HOP	Use Rate/Year	400 hours

APPENDIX C
ACRONYMS

AD. . . . . Advanced Development

AMC . . . . Army Materiel Command

BCE . . . . Baseline Cost Estimate

CAIDES. . . . . . . Computer Aided Interactive Data Entry System

DA PAM. . . . . . . Department of the Army Pamphlet

DS. . . . . Direct Support

DVAL. . . . . Demonstration and Validation

ED. . . . . Engineering Development

FSD . . . . Full Scale Development

GS. . . . . General Support

ICE . . . . Independent Cost Estimate

LCCAM . . . . Life Cycle Cost Analysis Model

MRSA. . . . . Materiel Readiness Support Activity

CNVEO . . . . Center for Night Vision and Electro-Optics

OMA . . . . Operation Maintenance Appropriations

O&S . . . . Operation and Support

PEMA. . . . . Procurement Equipment and Missiles, Army

POM . . . . Program Objective Memorandum

R&D . . . . Research and Development

TOC . . . . To Completion

APPENDIX D

DISTRIBUTION LIST

DISTRIBUTION:

COMMANDERS
AMCCOM (AMSMC-LS(R)/AMSMC-RDA-S)
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ARI (PERI-SM)
AVSCOM (AMSAV-LFS/AMSAV-BB)
BRDC (STRBE-TIS/STRBE-H)
CECOM (AMSEL-LO/AMSEL-PL-SA/AMSEL-ME-ME/AMSEL-POD-SA)
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CSLA (SELCL-NMP-MM)
CTA (AMXCT-SS)
DESCOM (AMSDS-SM-I/AMSDS-X)
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